PATENT COOPERATION TREATY

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From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	13.07.2004

Applicant's or agent's file reference	IMPORTANT NOTIFICATION
10467.57WOU1	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 03/07139	10.03.2003	08.03.2002

Applicant
CONDUCTUS, INC. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:	Authorized Officer
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Form PCT/IPEA/416 (January 2004)

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 10467.57WOU1	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US 03/07139	International filing date *(day/month/year)* 10.03.2003	Priority date *(day/month/year)* 08.03.2002
International Patent Classification (IPC) or both national classification and IPC H01P1/203		
Applicant CONDUCTUS, INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
08.10.2003	13.07.2004
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Plathner, B-D Telephone No. +49 89 2399-7987

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US 03/07139

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1, 2, 4-9	as originally filed
3, 3A, 10	filed with telefax on 21.05.2004

Claims, Numbers

2-10	as originally filed
1, 11-15	filed with telefax on 21.05.2004

Drawings, Sheets

1/7-7/7	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2,10,11
	No:	Claims	1,3-9,12-15
Inventive step (IS)	Yes:	Claims	11
	No:	Claims	2,10
Industrial applicability (IA)	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

   see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:
D1: US5351020
D2: WO9800880

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1,3-9,12-15 is not new in the sense of Article 33(2) PCT and because the subject-matter of claims 2,10 does not involve an inventive step in the sense of Article 33(3) PCT.

1 **Claim 12**, the broadest independent apparatus claim, is not new in the sense of Article 33(2) PCT because US5351020 (D1) discloses a filter for electrical signals comprising:

a: two resonators (Fig. 1,2,19 ref. 42,43), each having a first end and a second end; and

b: the first end and the second end being arranged and configured to lie on the same side of one first resonator and proximate the second resonator, and wherein a first distance (Fig. 2, ref. L_7) of the first end from the second resonator creates a primary coupling between the first and second resonators and a second distance (Fig. 2, ref. L_7) and length of the second end (defined via ref. L_1 in Fig. 1) creates a secondary coupling between the first and second resonators. The overall distance of the first and second resonators from one another is optimized by controlling either the primary (col. 7, lines 16-21) or the secondary (col. 5, lines 21-27) coupling.

1.1 It should be noted that "independently controlling the primary or secondary coupling" can also be understood as "controlling the primary coupling without affecting the secondary coupling and vice versa". This interpretation seems however not to have a basis in the application as originally disclosed (Article 34(2)(b) PCT.

2 **Claim 1** lacks novelty (Article 33(2) PCT) because of the arguments listed in paragraph 1 of the present communication and is not appropriately formulated as a claim dependent on claim 12 since it comprises all the features of the latter (Rule 6.4 PCT).

3 **Claim 3** lacks novelty (Article 33(2) PCT) because one end (Fig. 2,19 ref. 42c) of one resonator of the filter of D1 is arranged and configured to provide a substantially larger interface to the second resonator than the other end (Fig. 2,19, ref. 42a).

4 **Claims 4** and **13** lack novelty (Article 33(2) PCT) because the filter of D1 comprises a coupling strip (Fig. 19,20, ref 5) which couples one end of the first resonator to the second resonator.
It should be noted that the earth electrode pattern (Fig. 19,20 ref 5) is shaped into a strip-like form, for example with a laser trimming method (col. 10, lines 17 - 23).

5 The subject-matter of **claim 5** and its corresponding method **claim 14** lacks novelty (Article 33(2) PCT) because in the filter of D1, the primary coupling is a function of the distance (Fig. 2, ref. L_7) between the first and second resonators, and the secondary coupling is a function of:

- the distance between the coupling strip (Fig. 19,20, ref. 5) and the first resonator (Fig. 19 ref. 42),
- the length of the coupling strip which lies adjacent to the first resonator (right part of the strip ref. 5 in Fig. 20),
- the distance between the coupling strip and the second resonator (Fig. 19 ref. 41), and
- the length of the coupling strip which lies adjacent to the second resonator (central part of the strip ref. 5 in Fig. 20),

and the total coupling is the sum of said primary and secondary couplings.

6 **Claims 6-8** lack novelty (Article 33(2) PCT) because in the filter of D1 primary or

secondary couplings can be either capacitive or inductive.

7 **Claim 9** and its corresponding method **claim 15** lack novelty (Article 33(2) PCT) because the filter of D1 comprises one non-adjacent resonator device (Fig. 19, ref. 41) and a coupling strip (Fig. 19,20, ref. 5) between the first resonator (Fig. 19, ref. 42) and said non-adjacent resonator device (Fig. 19, ref. 41).

8 The subject-matter of **Claim 2** differs from the known filter of D1 only in that a High Temperature Superconducting (HTS) material is employed for the construction of the resonator's strip lines.
However, the skilled person generally knows about the option of realising strip lines in HTS configuration, (for example from D2, col. 6, lines 25-45) and their superior performance in resonators. Consequently, the solution presented in claim 2 cannot be considered as involving an inventive step (Article 33(3) PCT).

9 **Claim 10** does not involve an inventive step (Article 33(3) PCT) because the claimed substrate materials are generally known and would be applied to the known filter of D1 whenever circumstances make it desirable.

10 The subject-matter of **claim 11** differs from the known filter of D1 in that claim 11 claims a location of said coupling strip (Fig. 19,20, ref 5) in the same plane as the resonators. This can result in an advantage for the micro strip filter fabrication.

Claim 11 is considered as involving an inventive step (Article 33(3) PCT) because there is no hint in the prior art, that would prompt a skilled person to depart from the compact multi layer concept of D1 in order to achieve a more advantageous micro strip fabrication.

11 The vague and imprecise statement in the description on page 10, lines 11-13, in

particular the passage "changes may be made in detail" implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

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U.S. Patent No. 5,351,020 generally discloses a band-pass filter having three or more loop shaped electrodes. However, this reference does not disclose varying the length and distance of the second end of the electrode in order to provide a secondary coupling. Further, the coupling strip requires a secondary layer lying above the strip line configuration and is not included in the plane of the resonator elements.

Therefore, there exists a need for a very-narrow bandwidth filter having the convenient fabrication advantage of microstrip filters while achieving, in a small filter, the appropriate coupling. Further, the appropriate coupling should take advantage of cross-coupling between non-adjacent resonators to introduce transmission zeros which provide an optimized transmission response of the filter.

Summary of the Invention

The present invention provides for a method and apparatus to provide appropriate coupling between resonators in an HTS microstrip filter. The present invention uses the concept of primary and secondary couplings between a pair of resonators. With a given spacing, the primary coupling is fixed, while the secondary coupling can have different magnitude. In addition, the secondary coupling can have the same phase or opposite phase as the primary coupling. With different combinations, large or small bandwidth filters can be made without very small or very large spacing between adjacent resonators. The same cross coupling layout configuration may be designed to achieve either positive or negative results.

One feature of the present invention is that the resonator is designed to have both ends accessible from one side of the resonator. Because of the current flow in a resonator, orienting the two ends of the resonator toward the same side allows the primary and secondary coupling to be added or subtracted from one another through relatively simple design changes. Another feature includes arranging and configuring a first end of the resonator with a substantially larger interface to the adjacent resonator than the second end of the resonator. The primary coupling between the resonator is generally associated with the first larger interface end of the resonator to the adjacent resonator. The secondary coupling is generally associated with the second smaller interface end of the resonator to the adjacent resonator, but the secondary coupling may also be assisted by an additional coupling strip.

Therefore, according to one aspect of the invention, there is provided a resonator apparatus, of the type used in filters for an electrical signal, comprising: a first resonator device, having a first end and a second end; a second resonator device; and wherein the first end and the second end are arranged and configured to lie on the same side of the

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first resonator and proximate the second resonator, and wherein the distance of the first end from the second resonator creates a primary coupling between the first and second resonators, and the distance and length of the second end creates a secondary coupling between the first and second resonators, whereby the overall distance of the first and second resonators from one another may be optimized by controlling either the primary or secondary coupling.

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As will be apparent to those of skill in the art, the principles of this style of cross coupling may also be used in environments in which other types of filter construction methodologies are employed. For example, the resonators described herein can be used with other types of resonators to achieve desired response shape, filter performance, layout, cost, etc. It will also be appreciated, that the principles of this invention apply to control cross-coupling between non-adjacent resonant devices in order to improve filter performance.

It is to be understood that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only and changes may be made in detail. [Other modifications and alterations are well within the knowledge of those skilled in the art and are to be included within the broad scope of the appended claims].

ART 34 AMDT What is claimed is:

1. A resonator apparatus, of the type used in filters for an electrical signal, comprising:

a. a first resonator device, having a first end and a second end;

b. a second resonator device; and

c. wherein the first end and the second end are arranged and configured to lie on the same side of the first resonator and proximate the second resonator, and wherein a first distance of the first end from the second resonator creates a primary coupling between the first and second resonators, and a second distance and a length of the second end creates a secondary coupling between the first and second resonators, whereby the overall distance of the first and second resonators from one another may be optimized by independently controlling the primary or secondary coupling.

2. The resonator apparatus of claim 1, wherein the first and second resonator devices are constructed in an HTS microstrip configuration.

3. The resonator apparatus of claim 1, wherein the first end is arranged and configured to provide a substantially larger interface to the second resonator than the second end.

4. The resonator apparatus of claim 1, further comprising a coupling strip which couples the second end to the second resonator.

5. The resonator apparatus of claim 4, wherein the primary coupling ***F1*** is a function of the distance ***S1*** between the first and second resonators , and the secondary coupling ***F2*** is a function of ***S2a, S2b, L2a*** and ***L2b*** where ***S2a*** is the distance between the coupling strip and the first resonator and ***L2a*** is the length of the coupling strip which lies adjacent the first resonator, ***S2b*** is the distance between the coupling strip and the second resonator and ***L2b*** is the length of the coupling strip which lies adjacent the second resonator, wherein the total coupling between the first resonator and the second resonator, ***F***, is defined by:

$$F = F1(S1) + F2(S2a, S2b, L2a, L2b).$$

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6. The resonator apparatus of claim 1, wherein the primary coupling can be either capacitive or inductive and the secondary coupling can be either capacitive or inductive.

7. The resonator apparatus of claim 1, wherein the primary coupling can be either capacitive or inductive.

8. The resonator apparatus of claim 1, wherein the secondary coupling can be either capacitive or inductive.

9. The resonator apparatus of claim 1, further comprising at least one non-adjacent resonator device and a coupling strip between the first resonator and the at least one non-adjacent resonator device.

10. The resonator apparatus of claim 2, wherein the micro-strip topology includes a dielectric substrate of either MgO, $LaAlO_3$, $Al_2)_3$, or YSZ

11. The resonator apparatus of claim 1, wherein the first and second resonator devices generally define a mean plane and further comprising a coupling strip which couples the second end to the second resonator, the coupling strip being located in the mean plane.

12. A filter for electrical signals, comprising:

a. a plurality of resonators, at least one resonator having a first end and a second end; and

b. the first end and the second end being arranged and configured to lie on the same side of the at least one first resonator and proximate a second resonator, and wherein a first distance of the first end from the second resonator creates a primary coupling between the at least first and second resonators, and a second distance and a length of the second end creates a secondary coupling between the at least first and second resonators, whereby the overall distance of the at least first and second resonators from one another may be optimized by independently controlling the primary or secondary coupling.

13. A filter for electrical signals, comprising:

a. a first resonator device;

b. a second resonator device;

c. a coupling strip between the first and second resonators; and

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d. the first resonator device and the second resonator device having a primary coupling and a secondary coupling between the first and second resonators, wherein the overall distance of the first and second resonators from one another establishes the primary coupling and the distance between the coupling strip and the overlap with the first and second resonators establishes the secondary coupling, whereby the distances between adjacent resonators may be optimized by controlling either the primary or secondary coupling.

14. A method of controlling coupling in an electric signal filter, having a first and second resonator and a coupling strip, comprising the steps of:

a. determining the primary coupling between the first and second resonators based on the desired distance between the first and second resonators;

b. determining the desired secondary coupling in order to arrive at the total desired coupling between the first and second resonators; and

c. determining the distances and lengths of the coupling strip from the first and second resonators to achieve the determined secondary coupling ***F2***, where ***F2*** is a function of ***S2a***, ***S2b***, ***L2a*** and ***L2b***, and ***S2a*** is defined as the distance between the coupling strip and the first resonator, ***L2a*** is the length of the coupling strip which lies adjacent the first resonator, ***S2b*** is the distance between the coupling strip and the second resonator, and ***L2b*** is the length of the coupling strip which lies adjacent the second resonator, the primary coupling ***F1***, wherein the total coupling between the first resonator and the second resonator, ***F***, is defined by:

$$F = F1(S1) + F2(S2a, S2b, L2a, L2b).$$

15. The method of claim 14, further comprising the step of locating at least one non-adjacent resonator device and a coupling strip between the first resonator and the at least one non-adjacent resonator device.

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